

ZINC

By Jozef Plachy

Domestic survey data and tables were prepared by Samir Hakim, statistical assistant, and the world production tables were prepared by Regina R. Coleman, international data coordinator.

In 2003, domestic zinc mine production, expressed in zinc content of ore, decreased by about 2% compared with that of 2002, according to the U.S. Geological Survey (USGS). Based on recoverable content of concentrate and annual average U.S. price, the value of zinc mine production was estimated to be about \$661 million, slightly less than that of 2002. By the end of 2003, only 10 mines in 5 States were operating in the United States. Because of mine closures in the past 2 years, Alaska fortified its position as the leading producer of zinc concentrate, followed by Missouri, Tennessee, and Montana. In 2003, as in every year since the opening of Alaska's Red Dog Mine in 1989, U.S. mine production greatly exceeded smelter capacity, necessitating exports of concentrate and imports of refined zinc metal (tables 1, 6). Most of the zinc concentrate, supplied entirely by the Red Dog Mine, was exported to Canada, followed by the Republic of Korea, Japan, and Belgium. Zinc metal production in the United States, which was provided by 2 primary smelters and 13 large- and medium-sized secondary smelters, increased by about 3% in 2003 (table 4). More than one-half of zinc metal imports was from Canada, followed by Mexico and Peru.

Apparent domestic consumption of refined zinc metal in 2003 decreased to about 1.1 million metric tons (Mt). About one-half of metal consumed in the United States was used for galvanizing, followed by use in zinc-base alloys and brass and bronze (table 11). Zinc compounds and dust were used primarily by the agriculture, chemical, paint, and rubber industries.

The average U.S. producer price for Special High Grade zinc in 2003, which was based on the London Metal Exchange (LME) daily cash price plus premium, increased by about 5% to \$0.90 per kilogram (40.63 cents per pound) (table 1).

Legislation and Government

Fine-grained sediments in Lake Roosevelt in Washington State that contain arsenic, lead, and other trace elements are thought to be scattered by wind during the annual drawdowns of water between January and April. During this period, lake levels are lowered by as much as 25 meters to make room for high river flows from spring runoff (U.S. Geological Survey, 2003§¹). The data were turned over to the Washington State Department of Health and the U.S. Environmental Protection Agency (EPA) for followup studies. The EPA determined that Teck Cominco Ltd.'s Trail lead and zinc smelter and Celgar Pulp Mill in Castlegar, British Columbia, Canada, were the major sources of pollution. The EPA also wanted to designate the 200-kilometer-long reservoir behind Grand Coulee Dam as a Superfund cleanup site (Seattlepi, 2003§). The Government of Canada advised Teck Cominco that it opposed the application of U.S. laws in Canada and was considering its own course of action. Teck Cominco also claimed that it should not have been singled out as the only polluter because many companies operated in the area in the past (Metal-Pages, 2003k§).

Environmental Issues

The Society of Toxicology and Chemistry sponsored a workshop to evaluate the criteria used to assess the hazard of metals and inorganic metal substances to the environment. Hazard identification and classification procedures used in many countries are currently based upon bioaccumulation, persistence, and toxicity (PBT) criteria, originally developed for organic substances. The workshop, held in Pensacola, FL, in May 2003, concluded that applying PBT criteria to metals and inorganic substances has significant limitations. Traditional degradation processes used to evaluate biodegradation and persistence of organic substances are not applicable to metals. Accumulation factors are inversely related to exposure and may not be reliable indicators of chronic toxicity or food chain accumulation. Metal elements and some inorganic metal compounds are not readily soluble, and to some extent, many organisms appear to regulate their accumulation. In conclusion, the workshop recommended a new approach that integrated bioaccumulation, environmental chemistry, and toxicity. A critical load calculation was proposed as a means of assessing the significance of bioaccumulation and toxicity in aquatic and terrestrial environments (International Lead and Zinc Research Organization Environmental Update, 2003).

Production

Mine.—Construction of Teck Cominco's Pend Oreille Mine, WA, was completed at the end of 2003. The mill was expected to start in January 2004 and reach a full production rate of 55,000 metric tons per year (t/yr) of zinc in concentrate by the end of the first quarter. Teck Cominco estimated that the mine would employ about 170 people from the nearby communities of Ione, Metaline, and Metaline Falls for an 8-year period. Ore from the underground mine, which would be operated by Teck Cominco American Inc., was

¹References that include a section mark (§) are found in the Internet References Cited section.

to be transported to the surface by an existing conveyor system and milled onsite. Concentrate will be shipped to the company's Trail, British Columbia, Canada, smelter (CRU International Ltd., 2004).

The Montana Tunnels Mine, acquired by Apollo Gold Corp. in 2002, secured \$23 million to prestrip waste rock and expose deeper ores, upgrade equipment, and lift the embankment of the tailing impound. The redevelopment program was altered when the southwest pit wall, which was not scheduled for further development until 2004, collapsed in July 2002. An additional \$6 million was spent in 2002 and 2003. By the second quarter of 2003, the company had resumed ore production, and the mill was restarted to process lower grade development ore (Apollo Gold Corp., 2003§). Byproduct lead and zinc will be recovered from gold ore. Montana Tunnels Mine had proven and probable reserves totaling 17.3 Mt grading 0.6% zinc at yearend 2002 (CRU International Ltd., 2003c).

In May 2003, Pasminco Ltd. of Australia closed its Gordonsville Mine in Smith County, TN, when the new Cumberland ore body did not prove to be economically viable given the low zinc prices. The Clinch Valley Mine in Grainger County, TN, was expected to continue operating until reserves are exhausted in mid-2004. Both mines have supplied all their zinc concentrate output to Pasminco's 125,000-t/yr Clarksville, TN, smelter (CRU International Ltd., 2003d, p. 9). In September, Pasminco agreed to sell its Gordonsville and Clinch Valley zinc mines and related facilities to Tennessee Valley Resources (TVR). However, Pasminco will retain ownership of the Clinch Valley Mine until the remaining ore is mined out, and of the Clarksville zinc plant, which is reported to be among the most efficient midsize zinc processing plants in the world (Metal-Pages, 2003h§). TVR wants to use stockpiles at both mines as a source of agricultural lime for Mossy Creek Mining LLC. In addition to Pasminco's mines, TVR also bought the New Market and Young zinc mines in Tennessee previously owned by Asarco Incorporated (CRU International Ltd., 2003e).

The U.S. Bankruptcy Court for the Southern District of New York authorized the sale of the idled Zinc Corp. of America (ZCA) Balmat zinc mine in New York to St. Lawrence Zinc, a Delaware-based subsidiary of Canada's OntZinc Corp. The mine had been on care and maintenance since May 2001 when ZCA (a subsidiary of Horsehead Industries Inc.) decided to convert its Monaca, PA, smelter from primary to secondary zinc production. After securing a bridge loan for closing expenditures, standby costs at the mine, interest, and the assumption of a \$1 million environmental bond, OntZinc took possession in September 2003 (Platts Metals Week, 2003d). The company planned to reopen the mine in early 2004 and process ore at a rate of 440,000 t/yr, which it could increase to 500,000 t/yr by the third year of operations. Concentrates are to be sent to Canadian Electrolytic Zinc Ltd. (CEZinc) in Valleyfield, Quebec, Canada (owned by Noranda Inc.) (CRU International Ltd., 2003f). Balmat Mine had a predicted mine life of about 10 years (Platts Metals Week, 2003a).

Smelter.—Big River Zinc Corp. added a second automated cathode stripping machine to its Sauget, IL, refinery. The refinery now has two automated stripping units each producing 38% of total production; the remaining 24% is still stripped manually. The new cathode stripping machine, which was part of a \$10 million upgrade investment, reduced labor costs without changing the refinery's nameplate capacity of 92,000 t/yr (Platts Metals Week, 2003b).

On December 23, 2003, the sale of all the operating assets of Horsehead to SUN Capital Partners Inc. (an affiliate of the SUN Group) was approved by the U.S. Bankruptcy Court for the Southern District of New York where Horsehead had filed for Chapter 11 bankruptcy protection in August 2002. These assets included ZCA, Horsehead Resource Development Co. (HRD), and ZCA Powders, employing a total of about 1,000 people. ZCA operates the largest zinc recycling facility in the United States, a 180,000-t/yr smelter in Monaca, PA. HRD owns flue dust recycling facilities in Beaumont, TX; Calumet, IL; Palmerton, PA; and Rockwood, TN. The assets exclude the Balmat Mine that was sold separately to OntZinc. After the \$73 million purchase, Horsehead was renamed Horsehead Corp. (Platts Metals Week, 2004).

Teck Cominco began selling zinc metal produced by CalEnergy Minerals LLC in California. CalEnergy was reported to be producing about 8 metric tons per day (t/d) of high-grade zinc. The projected production was 30,000 t/yr (CRU International Ltd., 2003h).

Prices

European zinc smelters were handicapped by the continued appreciation of the euro against the dollar in 2003. By midyear the euro was at \$1.17, worth nearly 40% more than when the currency was at its weakest in July 2001. The once weak euro provided a significant cushion to European smelters because their revenues derived from realized dollar-denominated treatment charges (CRU International Ltd., 2003g). The high value of the euro was the main cause for the closure of four primary smelters: Avonmouth in the United Kingdom, Noyelles-Godault in France, Titov Veles in Macedonia, and Porto Vesme in Italy. Consequently, European refined zinc production in 2003 was about 6% lower than in 2002 and nearly 3% below consumption (International Lead and Zinc Study Group, 2004b).

World Review

Australia.—Consolidated Broken Hill (CBH) Ltd. of Australia acquired the Elura zinc-lead-silver mine in New South Wales from Pasminco for \$22 million including \$11.8 million for environmental cleanup. CBH planned to invest \$14 million to increase output by 6%, double reserves, and reduce unit operating cost by 11%. Before the sale, the Elura Mine was producing ore at a rate of 1.2 million metric tons per year (Mt/yr) containing about 73,000 t of zinc, 42,000 t of lead, and 27 t of silver (Metal-Pages, 2003d§). By yearend 2003, production rate at the Elura (now renamed Endeavor) Mine reached the previous production rate of 1.2 Mt/yr of ore. An increase to 1.4 Mt/yr of ore production was planned by the first half of 2004 (Metal-Pages, 2003c§).

Pasminco closed its Cockle Creek smelter near Newcastle, New South Wales, in September 2003 rather than between 2006 and 2008 as was previously announced. The reasons for advancing the closure included low treatment charges, the strengthening value of the Australian dollar, higher than expected expenditure requirements for meeting future environmental standards, and increasing difficulties in meeting production targets while operating an aging plant (Pasminco Ltd., 2003§).

After long negotiations that began in 2002, Switzerland-based Xstrata plc acquired MIM Holdings Ltd. of Australia for a cash price of \$1.04 per share. The takeover was approved by the Supreme Court of Queensland and the shareholders of both companies (Mining Journal, 2003d). MIM's zinc operations were centered near the Mount Isa Mine in Queensland and the McArthur River Mine in Northern Territory, primarily involving base-metal mining and copper smelting. Zinc concentrate will continue to be sold on the open market, a practice that began when MIM's loss-incurring zinc smelters at Duisburg, Germany, and Avonmouth, United Kingdom, were sold in 2003 (Platts Metals Week, 2003e).

Teck Cominco bought all of Western Metals Ltd.'s mineral properties, plant, equipment, and infrastructure at the Lennard shelf in Western Australia for about \$18 million. Soon after the purchase, the Pillara and Kapok lead-zinc mines were put on care and maintenance to give Teck Cominco time to prepare plans for improved production. The decision to restart the Lennard Shelf mines will depend on the outcome of the predevelopment program, zinc market conditions, and exchange rates. During the last fiscal year, which ended on June 30, 2003, Lennard shelf mines produced 176,000 t of zinc and 70,000 t of lead in concentrates (Metal-Pages, 2003j§).

Canada.—Noranda Inc. planned to close its Bell-Allard zinc mine in Matagami, Quebec, in the fourth quarter of 2004 owing to depletion of ore reserves. Development of its Perseverance zinc deposit, which was to replace Bell-Allard production, has been postponed owing to weak market conditions and depressed zinc prices. Since its discovery in 2000, Noranda has invested \$10 million in the Perseverance deposit, including a drilling and feasibility study. The high-grade deposit consists of three zones: Perseverance, Perseverance West, and Equinox, located in the Matagami region in Quebec. Reserves are estimated to be 5.1 Mt grading 15.8% zinc, 1.2% copper, 29 grams per metric ton (g/t) silver, and 0.4 g/t gold (Metal-Pages, 2003g§).

China.—Consumption of zinc, mostly for galvanizing, continues to increase in China. For 2003, galvanized steel output was around 3.7 Mt, a 1.4-Mt increase from that of a year ago, consuming an additional 70,000 metric tons (t) of refined zinc. Domestic consumption will likely be boosted in January 2004 by an expected lowering of the export rebate to 11% from the current average of 15% (Antaika, 2003b, p. 2). At the same time that China's Government is closing small, inefficient smelters, consumption of zinc metal is increasing at an annual rate of about 12% and is expected to reach 1.5 Mt by 2005. By that year, zinc production will probably be more than 2.2 Mt, owing to expansion of large-scale enterprises and construction of new and more efficient plants. Production of zinc concentrate, however, will probably continue to lag behind smelter expansion, necessitating increased imports of concentrate, which could reach 0.5 Mt by 2005 (Antaika, 2003a, p. 2). While the amount of concentrate imports in 2003 remained about as high as during the previous year, the sources have changed. Reduced imports from Kazakhstan owing to the opening of Kazakhmys Corp.'s new smelter were replaced by increased imports of bulk concentrate from Australia and zinc concentrate from India (CRU International Ltd., 2003b, p. 8).

Ireland.—Arcon International Resources plc of Ireland has identified a measured resource in the vicinity of its Galmoy Mine amounting to 2.3 Mt grading 19.8% zinc, 7.6% lead, and 65 g/t silver. Together with the remaining estimated 2 Mt of indicated resources grading 20.6% zinc, 8.1% lead, and 75 g/t silver, Arcon will be able to extend the mine's life into the next decade (Metal-Pages, 2003a§). When commercial production from the new deposit begins, Arcon expects to maximize concentrate production by blending a portion of ore from the new deposit with that from remaining reserves to process 750,000 t/yr at a blended grade of 13.3% zinc in 2004 and 14.4% zinc in 2005 (Metal-Pages, 2003b§).

Ivernia West Inc. of Canada sold its 50% interest in the Lisheen zinc mine in Ireland to its partner Anglo American plc, for \$1.8 million plus the assumption by Anglo American of Ivernia's debt totaling \$73 million making Anglo American the sole owner of the mine. The stated reasons for the sale were high debt levels and low profits generated by the Lisheen operation owing to low zinc prices (Mining Journal, 2003b).

Italy.—After management and union representatives failed to resolve the issue of high energy prices at a meeting with Italian Government officials and after operating at 20% below capacity for most of the 2003, Glencore International AG of Switzerland closed its Porto Vesme metallurgical complex in Sardinia in October 2003. The Porto Vesme complex consisted of an 80,000-t/yr imperial smelting process (ISP) zinc smelter, a 110,000-t/yr electrolytic zinc plant, a 90,000-t/yr Kivcet lead smelter, and a 120,000-t/yr lead refinery (Mining Journal, 2003a). Although the closure of Porto Vesme will have only a small effect on the supply of refined zinc, lost capacity because of closures by other primary processors in Europe changed Western zinc metal supply from a small surplus in 2002 to a large deficit in 2003. Zinc concentrate destined for Porto Vesme was redirected to Xstrata plc's San Juan de Nieva smelter in Spain, which lost its local supply when the Reocin Mine in Santander closed in May 2003 (CRU International Ltd., 2003a).

Kazakhstan.—In the last quarter of 2003, Kazakhstan's Kazakhmys Corp. commissioned its 100,000-t/yr zinc smelter in Balkhash, central Karagande, at a cost of about \$100 million. About three-quarters of the smelter's zinc concentrate requirement is to come from the company's own Vostokkamed and Zhezkent mines; together, they produced 72,300 t of zinc in concentrate in 2002, which was, before expansion, partly sold to Kazzink AO (Aksionernoye Obshchestvo-joint stock company) and partly exported to Russia (CRU International Ltd., 2003i).

Namibia.—Anglo American's Skorpion open pit zinc mine in Namibia officially commenced production in mid-2003 and should reach full capacity by the end of 2004. Skorpion's ore consists mainly of zinc oxide rather than the more usual sulfide ore. Anglo American built a dedicated processing plant to extract zinc metal through direct acid leaching, solid-liquid separation, solvent extraction, and electrowinning. Reserves amounted to 21.4 Mt grading 10.6% zinc (CRU International Ltd., 2003§). When it reaches

full production, it is expected to produce 150,000 t/yr of special high-grade zinc during a mine life of at least 15 years. The mine will employ about 600 people and contribute about 4% to the gross national product of Namibia (Metal-Pages, 2003i§).

Peru.—Peru has sold the last state-owned Morococha base-metal mine and concentrator to locally owned Sociedad Minera Corona S.A. In addition to the \$1 million sale price, the new owner (controlled by the Gubbins Group) must also invest \$240,000 annually for environmental cleanup and provide a minimum of \$3 million during the next 5 years to improve, expand, and develop Morococha's operations and installations. Corona also agreed to retain 350 workers for a minimum of 18 months. The mine, located in the Central Department of Junin, has proven and probable reserves of about 400,000 t grading 0.5% copper, 2.1% lead, 6.7% zinc, and 182 g/t silver. The site has an additional estimated 1 Mt of reserves (Metal Bulletin, 2003b).

Compañía Minera Volcán S.A. of Peru accepted the financial investment proposal submitted by Glencore. According to the proposal, Volcán would receive \$40 million in credit to be repaid during 7 years with a 2-year grace period. The credit was to be secured against the Andaychagua Mine and mill, part of the Yauli mining complex. The proposal also included a marketing agreement, under which Glencore had the right to purchase up to 50% of Volcán's zinc concentrate production. During 2003, Glencore became a major player in the zinc concentrate market as a trader and also through direct investment, mostly in Peruvian mining. Early in 2003, Empresa Minera Yauliyacu S.A., in which Glencore had a controlling interest, merged with Glencore-owned Empresa Minera Iscaycruz S.A. In the first half of the year, Glencore exported 266,000 t of Peruvian zinc concentrate, representing about 30% of that country's total exports (CRU International Ltd., 2003j). With the acquisition of Volcán, Glencore became the world's largest zinc producer, directly or indirectly controlling about 10% of total world production (Metal-Pages, 2003f§).

Spain.—In response to the closure of two European zinc smelters (a loss of 215,000 t/yr of capacity), Xstrata increased zinc production at its San Juan de Nieva smelter in Spain and its newly purchased Nordenham smelter in Germany. A 25,000-t/yr expansion at the former Asturiana de Zinc S.A. plant in Spain was finished in the third quarter of 2003, expanding the total capacity to 485,000 t/yr (a 35% expansion occurred in 2001). Two further expansions are planned for the San Juan de Nieva smelter in 2004. A debottlenecking of the roasting stage and modifications to electrodes could increase production to 492,000 t/yr, and the use of direct leaching could lift the output to 537,000 t/yr. Output at Nordenham is to be increased by 6,000 t/yr (from about 130,000 t in 2002) owing to increased imports of concentrate from Spain (Platts Metals Week, 2003f).

Xstrata closed its Reocin Mine in Spain owing to exhaustion of reserves. Although the closure had been anticipated, it happened sooner than expected (CRU International Ltd., 2003b, p. 11).

Sweden.—Boliden Ltd. and Outokumpu Oy of Finland announced plans to consolidate their upstream and downstream assets to create one company dedicated to mining and smelting (Boliden) and another focused on stainless steel, copper fabrication, and technology (Outokumpu). The merger was approved by the European Commission and other relevant competition authorities after Finnish regulatory agencies approved the company's plan to sell its upstream zinc and copper assets for \$865 million, and Outokumpu received an exemption from Swedish regulations that require companies to bid for the entire company when their shareholding exceeds 40%. The new company, to be called New Boliden Ltd., will become the sole owner of the Tara zinc mine in Ireland, the 260,000-t/yr Kokkola smelter in Finland, and the 150,000-t/yr Oda smelter in Norway. Combined production will elevate New Boliden to one of the world's biggest smelting operations and the fourth largest producer of zinc concentrate (Platts Metals Week, 2003c).

United Kingdom.—MIM closed its historic Avonmouth smelter, which was operated by MIM's wholly owned subsidiary Britannia Zinc Ltd. The closure of Avonmouth will complete MIM's exit from European zinc smelting, the plant at Duisburg having been sold in December 2001 (Metal-Pages, 2003e§). The Avonmouth smelter began the ISP revolution that, in the 1950s, was hailed as a technological breakthrough for smelting lead-zinc bulk concentrates. The process was developed by Imperial Smelting Corp. with the British Government's encouragement during World War II to ease dependence on imported zinc from Belgium and Germany. A unique feature of the ISP was its ability to recover lead and zinc simultaneously from bulk concentrates, which are difficult and expensive to separate. An additional advantage was its ability to accept large quantities of recycled material. The main disadvantage of the ISP was the low grade of the recovered zinc, which often had to be further refined. As the demand for high-grade zinc became widespread, the electrolytic process replaced the ISP as the zinc smelting technology of choice for many companies (Metal Bulletin, 2003a).

Current Research and Technology

At the Annual Conference of Metallurgists held by the Canadian Institute of Mining, Metallurgy and Petroleum in August, Teck Cominco unveiled and demonstrated its HydroZinc™ process of direct extraction of zinc metal from sulfide ore. The new process has four main components—bioleaching of ore in heaps with naturally occurring bacteria, followed by neutralization, solvent extraction, and electrowinning. The HydroZinc™ process, which does not require grinding and flotation of ore, produced zinc at a cost of about 20 cents per pound. The pilot plant, which was operated from October 2000 until December 2002, had a nominal capacity of 1 t/d. Two separate test heaps were constructed, treating a total of about 10,000 t of ore from Teck Cominco's Red Dog Mine in Alaska (Mining Journal, 2003c).

Outlook

According to International Lead and Zinc Study Group (2004a), world demand for refined zinc metal is expected to rise by 3.5% to 10.1 Mt in 2004. Mine output is expected to be 0.8% higher than in 2003 and to accelerate in 2005-06. More than one-half of the

750,000 t/yr of Western mine capacity, which was taken out of the market owing to low zinc prices, was on care and maintenance at yearend 2003. It is estimated that about 80% of these idle mines will be back in production by the end of 2005. There is another 436,000 t/yr of output associated with Western projects which was deemed probable. Production of refined zinc is expected to increase by 1.7% to about 10 Mt in 2004, slightly below consumption. This imbalance could result in zinc price increases.

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TABLE 1
SALIENT ZINC STATISTICS¹

(Metric tons unless otherwise specified)

	1999	2000	2001	2002	2003
United States:					
Production:					
Domestic ores, contained zinc	852,000	852,000	842,000	780,000	768,000
Domestic ores, recoverable zinc	808,000	805,000	799,000	754,000	738,000
Value, recoverable zinc thousands	\$953,000	\$987,000	\$774,000	\$664,000 ^r	\$661,000 ^e
Refined zinc:					
From domestic ores	180,000	137,000	169,000	151,000	155,000
From foreign ores	61,100	90,800	34,000	30,800	31,900
From scrap	131,000	143,000	108,000	113,000	116,000
Total	371,000	371,000	311,000	294,000	303,000
Secondary zinc ²	268,000	297,000	267,000	253,000	265,000
Exports:					
Ores and concentrates, zinc content	531,000	523,000	696,000	822,000	841,000
Slab zinc	1,880	2,770	1,180	1,160	1,680
Rolled zinc	3,870	3,530	5,700	7,200	9,430
Imports for consumption:					
Ores and concentrates, zinc content	74,600	52,800	84,000	122,000	164,000
Refined (slab) zinc	1,060,000	915,000	813,000	874,000	758,000
Rolled zinc	22,600	9,380	7,240	1,640	1,790
Stocks of slab zinc, December 31:					
Producer	9,960	7,890	7,380	8,550	7,660
Consumer	64,400	58,300	57,100	59,100	55,300
Merchant	9,690	10,500	10,300	9,970	10,300
Total	84,100	76,600	74,700	77,600	73,300
Government stockpile	177,000	138,000	120,000	109,000	95,200
Consumption, refined zinc:					
Reported	614,000	634,000	543,000	496,000	506,000
Apparent ³	1,430,000	1,330,000	1,150,000 ^r	1,170,000 ^r	1,080,000
All classes ⁴	1,700,000	1,630,000	1,420,000 ^r	1,420,000 ^r	1,340,000
Price, special high grade cents per pound	53.48	55.61	43.96	38.64	40.63
World:					
Production:					
Mine thousand metric tons	7,960 ^r	8,770 ^r	8,910 ^r	8,380 ^r	9,010 ^e
Smelter do.	8,550	9,090 ^r	9,340 ^r	9,650 ^r	9,880 ^e
Price, London Metal Exchange cents per pound	48.80	51.15	40.16	35.31	37.53

^eEstimated. ^rRevised.

¹Data are rounded to no more than three significant digits, except prices; may not add to totals shown.

²Zinc in metal products and compounds derived directly from scrap; refined secondary zinc is listed separately in the table.

³Domestic production plus net imports, plus or minus stock changes.

⁴Apparent consumption of refined zinc plus reported consumption of zinc in metal products and compounds derived directly from ore, concentrate, or scrap.

TABLE 2
MINE PRODUCTION OF RECOVERABLE ZINC
IN THE UNITED STATES, BY STATE¹

(Metric tons)

State	2002	2003
Alaska ²	660,000	656,000
Missouri	41,800	39,100
Montana	10,300	15,200
Other ³	41,900	27,800
Total	754,000	738,000

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Data based, in part, on publicly available information.

³Includes production from Idaho and Tennessee.

TABLE 3

LEADING ZINC-PRODUCING MINES IN THE UNITED STATES IN 2003, IN ORDER OF OUTPUT

Rank	Mine	County and State	Operator	Source of zinc
1	Red Dog	Northwest Arctic, AK	Teck Cominco Alaska Inc.	Lead-zinc ore.
2	Greens Creek	Juneau, AK	Kennecott Greens Creek Mining Co.	Zinc ore.
3	Brushy Creek	Reynolds, MO	Doe Run Resources Corp.	Lead ore.
4	Gordonsville	Smith, TN	Pasminco Ltd.	Zinc ore.
5	Montana Tunnels	Jefferson, MT	Montana Tunnels Mining, Inc.	Gold ore
6	Clinch Valley	Grainger, TN	Pasminco Ltd.	Zinc ore.
7	Buick	Iron, MO	Doe Run Resources Corp.	Lead ore.

TABLE 4
REFINED ZINC PRODUCED IN THE UNITED STATES¹

(Metric tons)

	2002	2003
Primary:		
From domestic ores	151,000	155,000
From foreign ores	30,800	31,900
Total	182,000	187,000
Secondary	113,000	116,000
Grand total ²	294,000	303,000

¹Data are rounded to no more than three significant digits;
may not add to totals shown.

²Excludes zinc recovered by remelting.

TABLE 5
REFINED ZINC PRODUCED IN THE UNITED STATES,
BY GRADE¹

(Metric tons)

Grade	2002	2003
Special high	94,000	97,100
Continuous galvanizing	108,000	110,000
Other ²	91,900	95,100
Total	294,000	303,000

¹Data are rounded to no more than three significant digits;
may not add to totals shown.

²Includes controlled lead, high, and prime western grades.

TABLE 6
SLAB ZINC CAPACITY OF PRIMARY ZINC PLANTS IN THE UNITED STATES,
BY TYPE OF PLANT AND COMPANY

(Metric tons)

Type of plant and company	2002	2003
Electrolytic:		
Big River Zinc Corp., Sauget, IL	100,000	100,000
Pasminco Ltd., Clarksville, TN	115,000	115,000
Electrothermic, Zinc Corporation of America, Monaca, PA	155,000 ¹	--
Total	370,000	215,000

-- Zero.

¹Includes secondary capacity.

TABLE 7
STOCKS AND CONSUMPTION OF NEW AND OLD ZINC SCRAP IN THE UNITED STATES
IN 2003, BY TYPE OF SCRAP¹

(Metric tons, zinc content)

Type of scrap	Stocks, January 1	Consumption				Stocks, December 31
		Receipts	New scrap	Old scrap	Total	
Diecastings	109	W	--	W	W	W
Flue dust	W	69,000	34,500	34,500	69,000	W
Galvanizer's dross	2,830	41,000	41,000	--	41,000	2,830
Old zinc ²	80	237	--	247	247	70
Remelt die-cast slab	103	W	--	W	W	W
Remelt zinc ³	W	W	W	--	W	W
Skimmings and ashes ⁴	529	22,400	22,400	--	22,400	W
Other ⁵	1,630 ^r	62,600	55,700	7,830	63,500	2,470
Total	5,270 ^r	195,000	154,000	42,500	196,000	5,370

^rRevised. W Withheld to avoid disclosing company proprietary data; included with "Other." -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes engraver's plates and rod and die scrap.

³Includes new clippings.

⁴Includes slab and die-cast skimmings.

⁵Includes chemical residues and solutions, electrogalvanizing anodes, fragmentized diecastings, and steelmaking dust.

TABLE 8
 PRODUCTION OF ZINC PRODUCTS FROM
 ZINC-BASE SCRAP IN THE UNITED STATES¹

(Metric tons)

Products	2002	2003
Redistilled slab zinc	113,000	116,000
Other zinc metal products ²	7,380	8,210
Zinc in chemical products	45,200	44,000
Zinc dust	5,040	4,070

^rRevised.

¹Data are rounded to no more than three significant digits.

²Includes electrogalvanizing anodes, remelt die-cast slab, and other metal alloys.

TABLE 9
ZINC RECOVERED FROM SCRAP PROCESSED
IN THE UNITED STATES BY TYPE OF SCRAP
AND FORM OF RECOVERY¹

(Metric tons)

	2002	2003
Type of scrap:		
New scrap:		
Zinc-base	147,000	149,000
Copper-base	171,000	146,000
Magnesium-base	548	548 ^e
Total	319,000	295,000
Old scrap:		
Zinc-base	44,400	40,900
Copper-base	2,040	9,340
Aluminum-base	548	548
Magnesium-base	338	338 ^e
Total	47,300	50,300
Grand total	366,000	345,000
Form of recovery:		
Metal:		
Slab zinc	113,000	116,000
Zinc dust	5,040	4,070
Total	118,000	120,000
In brass and bronze	198,000	176,000
In chemical products:		
Zinc oxide (lead free)	15,600	14,900
Zinc sulfate	24,700	24,000
Miscellaneous ²	10,200	9,950
Total	248,000	225,000
Grand total	366,000	345,000

^eEstimated.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes chlorine, electrogalvanizing anodes, and zinc content of slab made from remelt die-cast slab.

TABLE 10
U.S. CONSUMPTION OF ZINC¹

(Metric tons)

	2002	2003
Refined zinc, apparent	1,170,000 ^r	1,080,000
Ores and concentrates, zinc content	617	654
Secondary, zinc content ²	253,000	265,000
Total	1,420,000 ^r	1,340,000

^rRevised.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Excludes secondary slab zinc and remelt zinc.

TABLE 11

U.S. REPORTED CONSUMPTION OF ZINC IN 2003, BY INDUSTRY USE AND GRADE¹

(Metric tons)

Industry use	Special high grade	High grade	Prime western	Remelt and other grades	Total
Galvanizing	112,000	37,700	86,300	27,600	264,000
Zinc-base alloys	113,000	W	W	W	113,000
Brass and bronze	43,900	W	W	W	87,400
Other	40,400	22,300	22,400	--	XX
Total	310,000	60,000	109,000	27,600	506,000

W Withheld to avoid disclosing company proprietary data. XX Not applicable. -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 12
ZINC CONTAINED IN PIGMENTS AND COMPOUNDS PRODUCED
AND SHIPPED IN THE UNITED STATES^{1, 2}

(Metric tons)

	2002		2003	
	Production	Shipments	Production	Shipments
Zinc oxide	29,500	29,500	31,700	31,700
Zinc sulfate	26,400 ^r	26,300 ^r	25,200	25,200

^rRevised.

¹Excludes leaded zinc oxide, lithopone, and zinc chloride.

²Data are rounded to no more than three significant digits.

TABLE 13
 REPORTED SHIPMENTS OF ZINC CONTAINED
 IN ZINC OXIDE, BY INDUSTRY^{1, 2}

(Metric tons)

	2002	2003
Ceramics	418	420
Chemicals	5,320	5,670
Paints	1,840	1,950
Rubber	21,000	22,500
Other ³	975	1,110
Total	29,500	31,700

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²In addition, zinc contained in zinc oxide was imported as follows: 2002--69,744 and 2003--98,345; distribution cannot be distinguished by industry.

³Includes agriculture and photocopying.

TABLE 14
U.S. EXPORTS OF ZINC ORES AND CONCENTRATES, BY COUNTRY¹

	2002		2003	
	Quantity (metric tons of zinc content)	Value (thousands)	Quantity (metric tons of zinc content)	Value (thousands)
Australia	29,800	\$13,200	24,400	\$10,900
Belgium	98,500	42,400	115,000	50,500
Canada	171,000	51,800	220,000	93,400
China	205	145	132	136
Germany	27,500	12,200	36,600	16,300
India	--	--	54,600	24,500
Italy	7,810	2,520	42,400	11,000
Japan	210,000	84,900	128,000	36,800
Korea, Republic of	78,100	29,200	142,000	58,100
Mexico	876	910	--	--
Netherlands	51,900	23,000	39,600	17,700
Saudi Arabia	28	45	--	--
Spain	122,000	54,100	39,200	17,500
United Kingdom	24,500	7,590	3	15
Other	42	95	149	113
Total	822,000	322,000	841,000	337,000

-- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 15
U.S. EXPORTS OF ZINC COMPOUNDS¹

	2002		2003	
	Quantity (metric tons of gross weight)	Value (thousands)	Quantity (metric tons of gross weight)	Value (thousands)
Zinc chloride	1,950	\$1,930	1,470	\$1,650
Zinc compounds, n.s.p.f.	5,880	8,720	6,730	9,570
Zinc oxide	10,800	14,600	12,100	15,200
Zinc sulfate	2,900	1,760	2,310	1,440

¹Data are rounded to no more than three significant digits.

Source: U.S. Census Bureau.

TABLE 16
U.S. IMPORTS FOR CONSUMPTION OF ZINC COMPOUNDS¹

	2002		2003	
	Quantity (metric tons of gross weight)	Value (thousands)	Quantity (metric tons of gross weight)	Value (thousands)
Lithopone	893	\$782	860	\$644
Zinc chloride	716	775	663	914
Zinc compounds, n.s.p.f.	--	--	1	5
Zinc hydrosulfite	161	317	248	312
Zinc oxide	69,700	57,600	98,300	72,200
Zinc sulfate	20,100	10,300	25,800	11,700

-- Zero.

¹Data are rounded to no more than three significant digits.

Source: U.S. Census Bureau.

TABLE 17

ZINC: WORLD MINE PRODUCTION (ZINC CONTENT OF CONCENTRATE AND DIRECT SHIPPING ORE UNLESS NOTED), BY COUNTRY¹

(Metric tons)

Country	1999	2000	2001	2002	2003 ^e
Algeria	9,808	10,452	10,693 ^r	8,576 ^r	5,201 ³
Argentina	34,192	34,858	39,703	37,325	37,000
Australia	1,163,000	1,420,000	1,519,000	1,154,000	1,480,000 ³
Bolivia	146,316	149,134	141,226	141,558 ^r	144,985 ^p
Bosnia and Herzegovina ^c	300	300	300	300	300
Brazil	98,590	100,254	111,432	136,430 ^r	200,000
Bulgaria ^c	10,200 ^r	9,400 ^r	12,100 ^r	13,000 ^r	13,000
Burma	279	437	467	350 ^{r, e}	300
Canada	963,321	1,002,242	1,012,048	894,399	1,000,000
Chile	32,263	31,403	32,762	36,161 ^r	36,200
China	1,480,000	1,780,000	1,700,000	1,550,000	1,650,000
Congo (Kinshasa)	--	215	1,014	1,000 ^e	1,000
Ecuador ^c	100	100	100	100	100
Finland	20,000 ^e	30,493	36,253	34,100	38,900 ³
Georgia ^c	400 ^r	200	350 ^r	400 ^r	400
Greece	19,619	16,900	31,700 ^r	33,000 ^r	20,000
Honduras	31,095	31,226	48,485	46,339	46,500
India ^c	145,000	144,000	146,000	129,000 ^r	162,000
Iran ^c	80,000	90,000	120,000	120,000	120,000
Ireland	226,000	262,877	225,135	252,700 ^r	250,000
Japan	64,263	63,601	44,519	42,851	44,574 ³
Kazakhstan	288,300	325,000	344,300	390,000	395,000 ³
Korea, North ^c	100,000	100,000	100,000	100,000	100,000
Korea, Republic of	9,832	11,474	5,129	99 ^r	--
Macedonia	7,900 ^r	12,200 ^r	6,300 ^r	2,100 ^r	2,500
Mexico	362,811	392,791	428,828	446,104 ^r	460,000
Morocco	111,703	103,064	89,339	91,000 ^{r, e}	70,000
Namibia ⁴	35,140	39,126	37,622 ^r	42,685 ^r	60,500 ³
Peru	899,524	910,303	1,056,629	1,221,830 ^r	1,250,000
Poland	154,800	156,900	152,700	152,200 ^r	150,000
Romania	26,536	27,455	29,786 ^r	25,000	25,000
Russia	132,000	136,000	124,000 ^e	130,000	125,000
Saudi Arabia	3,161	3,000 ^e	3,300	3,000 ^e	3,000
Serbia and Montenegro ^c	1,000	2,500	1,200	1,000 ^r	1,500
South Africa	69,733	62,703	61,221	64,173	41,239 ³
Spain	110,000	201,000	164,900 ^r	69,900 ^r	70,000
Sweden	174,400	176,788	156,334	148,600 ^r	186,900 ³
Thailand	24,000	27,000	15,300 ^r	33,600 ^r	32,900 ³
Tunisia	49,066	41,247	37,900 ^e	35,692 ^r	36,000
Turkey ⁵	545	39	37	35 ^e	35
United States	852,000	852,000	842,000	780,000	738,000 ³
Vietnam ^c	18,000	16,000	16,000	16,000	16,000
Total	7,960,000 ^r	8,770,000 ^r	8,910,000 ^r	8,380,000 ^r	9,010,000

^eEstimated. ^pPreliminary. ^rRevised. -- Zero.¹World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.²Table includes data available through July 1, 2004.³Reported figure.⁴Excludes mined ore going directly to leach solvent extraction-electrowinning at Skorpion plant.⁵Content in ore hoisted.

TABLE 18
ZINC: WORLD SMELTER PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

Country ³	1999	2000	2001	2002	2003 ^e
Algeria, primary and secondary ^e	32,200	34,000	34,000	26,136 ^{r, 4}	32,200
Argentina:					
Primary	40,224	36,359	39,727	38,699	39,221 ^p
Secondary	3,220	2,910	3,180	3,098	3,139 ^p
Total	43,444	39,269	42,907	41,797	42,360 ^p
Australia:					
Primary ⁵	344,000	490,000	554,000	567,000	553,000 ⁴
Secondary ^e	4,500	4,500	4,500	4,500	4,500
Total	348,500	494,500	558,500	571,500	557,000
Belgium, primary and secondary	232,400	251,700	259,300	260,000 ^e	244,000
Brazil:					
Primary	187,010	191,777	193,061	249,434 ^r	380,000
Secondary ^e	7,000	7,000	7,000	7,000	7,000
Total	194,010	198,777	200,061	256,434 ^r	387,000
Bulgaria, primary and secondary	83,700	84,200	88,600	83,000 ^r	85,000
Canada, primary	776,927	779,899	661,172	793,475	700,000
China, primary and secondary ^e	1,700,000	1,980,000	2,040,000	2,100,000	2,300,000
Czech Republic, secondary ^e	1,000	1,000	1,000	1,000	1,000
Finland, primary	225,200	222,881	247,179	235,300	265,900 ⁴
France, primary and secondary	333,103	350,000	347,000 ^e	350,000 ^e	253,000
Germany, primary and secondary	333,000	356,000	358,300	360,000	388,000
India: ^e					
Primary	175,000	176,000 ⁴	207,000 ^r	231,400 ^{r, 4}	253,900 ⁴
Secondary	25,000	25,000	25,000	24,000	24,000
Total	200,000	201,000	232,000 ^r	255,400 ^{r, 4}	277,900 ⁴
Iran	31,000	49,000	73,000 ^e	100,000 ^{r, e}	100,000
Italy, primary and secondary	152,800	170,300	177,800	176,000	123,000
Japan:					
Primary	524,979	541,704	541,277	547,183	532,704 ⁴
Secondary	158,637	157,047	142,777	126,723 ^r	153,411 ⁴
Total	683,616	698,751	684,054	673,906 ^r	686,115 ⁴
Kazakhstan, primary and secondary	249,327	262,200	277,100	286,300	294,965 ⁴
Korea, North, primary and secondary	100,000	100,000	100,000	100,000	100,000
Korea, Republic of, primary	430,108	473,897	508,000	600,027 ^r	600,000
Macedonia, primary and secondary ^e	55,000	69,800	95,093 ⁴	15,100 ^r	15,000
Mexico, primary	218,913	235,073 ^r	303,810 ^r	302,122 ^r	310,000
Namibia ⁶	--	--	--	35	47,436 ⁴
Netherlands, primary ⁶	220,000 ^e	216,800	204,800	203,000 ^{r, e}	223,000
Norway, primary	132,600	125,800	129,300	137,300	135,500 ⁴
Peru, primary	196,978	199,813	201,498	172,688	202,057 ⁴
Poland, primary and secondary	178,900	173,000 ^e	174,700	158,900 ^r	160,000
Portugal, primary ^e	3,600	3,600	3,600	3,600	3,500
Romania, primary and secondary	29,000	51,900	47,200	50,000 ^e	50,000
Russia, primary and secondary ^e	221,000	230,000	237,000	244,000	240,000
Serbia and Montenegro, primary and secondary	683	8,291	13,467	1,478	2,000
Slovakia, secondary ^e	1,000	1,000	1,000	1,000	1,000
South Africa, primary	108,000	103,000	109,000	105,000 ^e	115,000 ⁴
Spain, primary and secondary	393,000	386,300	418,000	488,000	530,000
Thailand, primary	75,639	77,525	74,129	72,502	73,000
Turkey, primary	33,179	--	-- ^e	-- ^e	--
United Kingdom, primary and secondary	132,800	76,000 ^r	90,000 ^{r, e}	98,000 ^{r, e}	14
United States:					
Primary	241,000	228,000	203,000	182,000	187,000 ⁴
Secondary	131,000	143,000	108,000	113,000	116,000 ⁴
Total	371,000	371,000	311,000	294,000	303,000 ⁴

See footnotes at end of table.

TABLE 18--Continued
ZINC: WORLD SMELTER PRODUCTION, BY COUNTRY^{1, 2}

(Metric tons)

Country ³	1999	2000	2001	2002	2003 ⁴
Uzbekistan, primary ⁵	27,000	18,000	35,000 ^r	30,000 ^r	30,000
Grand total	8,550,000	9,090,000 ^r	9,340,000 ^r	9,650,000 ^r	9,880,000
Of which:					
Primary	3,960,000	4,120,000 ^r	4,220,000 ^r	4,470,000 ^r	4,600,000
Secondary	331,000	341,000	292,000	280,000 ^r	310,000
Undifferentiated	4,260,000	4,630,000 ^r	4,830,000 ^r	4,900,000	4,960,000

⁶Estimated. ⁷Preliminary. ^rRevised. -- Zero.

¹World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Wherever possible, detailed information on raw material source of output (primary--directly from ores, and secondary--from scrap) has been provided. In cases where raw material source is unreported and insufficient data are available to estimate the distribution of the total, that total has been left undifferentiated (primary and secondary). To the extent possible, this table reflects metal production at the first measurable stage of metal output. Table includes data available through July 1, 2004.

³In addition to the countries listed, Israel also produces small amounts of secondary zinc, but available information is inadequate to make reliable estimates of output levels.

⁴Reported figure.

⁵Excludes zinc dust.

⁷Special high grade electrolytic cathodes from Skorpion plant.

⁶Sales.